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(19)


## (54) COATING COMPOSITIONS

(71) We, MONSANTO EUROPE S.A., a Belgian Company, of Avenue de Tervuren, 270—272, 1150 Bruxelles, Belgium, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to anti-corrosion coating compositions.

The use of paint formulations containing zinc powder (commonly called zinc-rich primers) to apply anti-corrosion protective coatings to ferrous metal surfaces is well known.

A variety of liquid binder media for such paint formulations has been proposed, both organic and inorganic, including aqueous alkaline silica sols. When a paint formulation employing a silica sol as the liquid vehicle dries, particles of powdered zinc are bonded by the gelation of the colloidal silica which occurs when the water evaporates.

A limitation on the use of silica sols as binding agents for particulate materials is that such sols are stable only over a relatively narrow range of conditions, and are sensitive to the presence of additives, particularly water-soluble additives, so that attempts to improve the performance of zinc-rich primers by experimenting with additives have rarely been successful.

We have now found that the presence of certain water-soluble polymers in zinc-rich primers having a silica sol as the liquid binding agent gives coatings with excellent mechanical properties.

The coating composition of the present invention comprises a mixture of zinc powder, an aqueous alkaline silica sol and a water-soluble acrylamide polymer (as hereinafter defined) having a molecular weight not exceeding $10^6$.

Preferred coating compositions of the invention contain in addition an inorganic bichromate and/or zonc oxide.

By a "water-soluble acrylamide polymer" is meant a water-soluble homopolymer of acrylamide or a water-soluble copolymer of acrylamide with one or more other monomers copolymerisable with acrylamide and containing not less than 50 molar percent of acrylamide units in the copolymer. Comonomers copolymerisable with acrylamide include olefins, for example ethylene and propylene, vinyl chloride, olefinic ethers, for example methyl vinyl ether, and polar monomers, for instance acrylonitrile, methacrylamide, N-alkylacrylamides, acrylic acid, methacrylic acid, maleic acid, and olefinic esters, for example vinyl acetate and methyl methacrylate. Preferred acrylamide copolymers for use in the present invention contain not less than 70 molar percent of acrylamide units.

Various aqueous alkaline silica sols suitable for use in the present invention are commercially available. The sols usually have a maximum stability when their pH lies in the range 9 to 11. The concentration of silica in the sols can vary from, for example, 15% to 50% by weight of the sol, and different sols also differ in the particle size of the silica. The particle size is conveniently expressed in terms of the surface area of the silica, the larger the particle size, the smaller the surface area.

The preferred sols for use in the present invention are those containing from 25 to 35% by weight of silica, although a composition can be formulated from a more concentrated sol and then diluted with water as required. With regard to particle size, the preferred sols have silica particles with a specific surface area of from 200 to 300 $m^2/g$, corresponding to a weight average particle size determined by light scattering of from approximately 30 to 20 n.m.

To provide adequate anticorrosive properties for most applications, the coating obtained by applying a coating composition of the present invention to a surface to be protected should, after drying, preferably contain at least 80% by weight of zinc, for example from 85 to 95% by weight of zinc. This requirement largely

determines the ratio of zinc to silica in the coating compositions of the invention. In practice it is necessary to achieve a balance between reducing the ratio of silica to zinc below a point at which the silica no longer functions effectively as a binding agent, and maintaining the zinc content of the compositions as high as possible in the interests of good corrosion inhibition. Using the preferred particle size silica sols referred to above, the balance is usually found at a zinc to silica weight ratio within the range 12:1 to 8:1.

The amount of zinc in a composition of the invention relative to the total weight of the composition is typically in the range 60—75%, the amount of silica is typically within the range 4—10%, and the amount of water within the range 35—15%. This represents an optimum between providing sufficient water to ensure that the composition is in an adequately fluid condition to be applied by brushing or spraying, and an unnecessary excess of water which would prolong drying times.

The particle size of the zinc may range from 1 to 20 microns, although particles of up to 25 microns or larger can be present. Preferably the bulk of the zinc particles have a size of from 2 to 15 microns.

Only a relatively small amount of the acrylamide copolymer need be present in order to exhibit the improvements observed with the compositions of the present invention. Generally, an amount of from 0.03 to 5% of the total weight of the composition can be used. The optimum will depend on the particular acrylamide polymer used, but for a polyacrylamide homopolymer having a molecular weight of about $10^5$, the optimum is from 0.08 to 0.12% by weight of the total composition.

In compositions containing an inorganic bichromate, the quantity of this component employed is usually from 0.01 to 5.0% by weight of the composition, with the preferred amount being from 0.05 to 1.5%. Sodium and potassium bichromates are very effective, while multivalent metal bichromates such as lead bichromate may also be used. The bichromate improves the storage stability of the composition by reducing gas evolution. It has anti-corrosive properties of its own, and it is also believed to have a cross-linking action on the acrylamide copolymer whereby films produced from compositions of the invention have improved water resistance.

In compositions containing zinc oxide, the amount of this component employed is usually from 1 to 20%, and preferably from 5 to 10%, by weight of the composition. The particle size of the zinc oxide is suitably from 0.1 microns up the particle size of the zinc used in the composition; preferably the zinc oxide has an average particle size within the range 0.3 to 1 micron. The presence of zinc oxide has been observed to give coatings having an improved water resistance, quicker touch-dry and curing time, and increased hardness.

The compositions of the invention can be prepared by simple mixing of the components at room temperature. As indicated above, it is generally convenient to select a silica sol having a silica concentration such that the silica sol alone provides the required amounts of silica and water in the final composition, but it is possible to start from a more concentrated sol and adjust the concentration with water as required.

The invention is illustrated by the following Examples.

Example 1

2 Grams of a polyacrylamide having a molecular weight of about $10^5$ and 1 gram of potassium bichromate were dissolved by stirring at room temperature in 920 grams of a silica sol having a pH of 9.8, a silica solids content of 30% by weight and a weight average particle size determined by light scattering of 25 n.m. To this dispersion there were then added with stirring 3080 grams of zinc powder having a particle size of about 6 microns.

The dispersion thus obtained was applied by spraying and by brushing on to grit-blasted steel strips. The coatings were touch dry in about 5 minutes and hard after 2 hours. Both methods of application gave coatings having good adhesion to the steel strips.

Example 2

4 Grams of a polyacrylamide having a molecular weight of about $10^5$ and 1 gram of potassium bichromate were dissolved by stirring at room temperature in 920 grams of a silica sol having a pH of 9.8, a silica solids content of 30% by weight and a weight average particle size determined by light scattering of 25 n.m. To this dispersion there were then added with stirring 2772 grams of zinc powder having a particle size of about 6 microns and 308 grams of zinc oxide having a particle size of 0.4 to 0.6 microns.

The dispersion thus obtained was applied by spraying and by brushing on to grit-blasted steel strips. The coatings were touch dry in about 5 minutes and hard after about 2 hours. Both methods of application gave coatings having good adhesion to the steel strips.

WHAT WE CLAIM IS:—

1. A composition comprising a mixture of zinc powder, an aqueous alkaline silica sol

and a water-soluble acrylamide polymer (as hereinbefore defined) having a molecular weight not exceeding $10^6$.

2. A composition according to Claim 1 containing, relative to the total weight of the composition, 60—75% of zinc, 4—10% of silica and 35—15% of water.

3. A composition according to either of Claims 1 and 2 in which the silica particles of the silica sol have a specific surface area of from 200 to 300 $m^2/g$.

4. A composition according to Claim 3 in which the zinc to silica weight ratio in the composition is within the range 12:1 to 8:1.

5. A composition according to any of Claims 1 to 4 in which the amount of the acrylamide polymer is from 0.03 to 5% by weight of the composition.

6. A composition according to any of Claims 1 to 5 in which the acrylamide polymer is an acrylamide homopolymer.

7. A composition according to Claim 6 in which the acrylamide homopolymer has a molecular weight of about $10^5$, and the amount is from 0.08 to 0.12% by weight of the composition.

8. A composition according to any of Claims 1 to 7 that contains from 0.01 to 5.0% by weight of the composition of an inorganic bichromate.

9. A composition according to any of Claims 1 to 8 that contains from 1 to 20% by weight of the composition of zinc oxide.

10. A composition according to Claim 1 substantially as described in either of Examples 1 and 2.

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